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EXAMINER	
BARTON, JEFFREY THOMAS	
ART UNIT	**PAPER NUMBER**
1753	

DATE MAILED: 05/17/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/087,264	VACCA ET AL.	
	Examiner	Art Unit	
	Jeffrey T Barton	1753	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-26* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,4-21 and 24-26* is/are rejected.

7)☒ Claim(s) *3,22 and 23* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *03 June 2002* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☒ Other: *Foreign patent document*.

DETAILED ACTION

Drawings

1. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: 400, 410, 412, 420, 422, 424, 426, 430, 432, and 818. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference number 1008 has been used to designate both a fluid within the channel and another feature not described in the specification. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claim 9 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Although there is discussion of "micron-size" indentations in the description of Figure 16a in the specification, the size of the indentations required and the specific meaning intended by "restrain" are not sufficiently defined in this claim. It can be accurately stated that flow is restrained by frictional forces caused by microscopic indentations present in any channel, no matter how smooth it appears. The claim must be more specific.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

6. Claims 1, 4, 6, 12, 15, 21, 24, 25 are rejected under 35 U.S.C. 102(b) as being anticipated by Auracher et al.

Addressing claim 1, Auracher et al disclose a device that is built on a substrate that is modified to produce walls that define a microchannel (Column 5, lines 4-20). This device further includes two electrodes that are positioned to form a capacitor having an electric field that crosses the microchannel (101 and 201 in Figure 5a; Column 5, lines 20-28), at least two distinct fluids having different dielectric constants (ambient gas and drop 14b in Figure 5a), and an interface between the fluids positioned between the electrodes such that the interface will move in the presence of an electric field applied between the electrodes (Figure 5a).

Addressing claim 4, Auracher et al disclose a channel (Figure 5a) that is uninterrupted over its length, and can thus be viewed as continuous between its ends.

Addressing claim 6, Auracher et al disclose channels that are illustrated in numerous figures to have two ends. For example, in Figure 5a the channel has ends defined by a) the junction of carrier body 30 with block parts 10 and 20, and b) the top of block parts 10 and 20.

Addressing claim 12, Auracher et al disclose a device in Figure 5a that includes two drops of dielectric fluid (14b and 14c), and apparently empty spaces in the channel that are filled with gas from the ambient atmosphere (a third fluid), as there is nothing in the disclosure of the process for constructing this device suggesting that steps were taken to exclude ambient gases. As illustrated in Figure 5a, the gas and drop 14b would correspond to the first and second fluids of the claim (with the interface between them lying between electrodes 101 and 201), and drop 14c would correspond to the third fluid of the claim, which is not immediately between the first and second electrodes (101 and 201).

Addressing claim 15, Auracher et al disclose a device in Figure 5a that uses three fluids, as shown above. They further disclose that drops 14b and 14c ". . . consist of two liquids . . . of which one is transparent and the other is opaque." (Column 5, lines 36-40). In an earlier description of the general invention showed in Figures 3 and 4, a usable liquid was described as being, "as transparent as possible and [having] an index of refraction of the waveguides 1' and 2'." (Column 4, lines 9-11). Drop 14c of Figure 5a

therefore could be a fluid with an index of refraction matched to the waveguides, and thus suitable for a core of an optical telecommunications device.

Addressing claim 21, Auracher et al disclose a method of using the device illustrated in Figure 5a, which shows an interface between the first and second fluids (gas and drop 14b), positioned between electrodes 101 and 201, which form a capacitor. By applying a voltage across the electrodes, the fluids (and thus the interface) move vertically within the channel. (Column 5, lines 40-48).

Addressing claim 24, Auracher et al disclose that both drops 14b and 14c move within the channel (Column 5, lines 45-51). If the ambient gas is considered to be the second fluid, with drop 14b corresponding to the first fluid, then drop 14c would be a third fluid that is in communication with the first fluid.

Addressing claim 25, Auracher et al disclose these devices as optical switches, which are optical telecommunications devices. Their patent is entitled, "Optical Device or Switch for Controlling Radiation in an Optical Waveguide."

7. Claims 1, 12, and 26 are rejected under 35 U.S.C. 102(b) as being anticipated by Batchelder.

Addressing claim 1, Batchelder discloses an apparatus for manipulating chemical species, which includes substrates (Figure 2, insulating plates 6) as walls that define microchannels with a typical dimension of 5 mils (~125 μm) for the gap (Column 7, line 6); first and second electrodes positioned to form a capacitor across the channel (Figure 1, electrodes 2; Column 3, lines 14-15); a first material (which can be a fluid – Column

3, lines 47-48; Figure 1, material 4) with a different dielectric constant from the surrounding medium 5, which must be a fluid for the device to function (fluidity is implied by reference to its viscosity: Column 3, line 24). The arrangement is such that the two fluids (and interface between them) will move upon the application of electric field across the channel (Column 3, lines 17-26).

Addressing claim 12, Batchelder discloses the manipulation of more than two materials in an embodiment of his invention. In the reactor illustrated in Figures 6 and 6a, if the first and second fluids are taken to be, for instance, a surrounding gas medium and liquid sample in ladder array 70, and the first and second electrodes of the claim are two opposing electrodes in ladder array 70, then a "bubble" or "drop" of buffer fluid passed through the channel between gate electrodes 68 will be a third fluid in the microchannel occupied by the sample and gas fluids, and not immediately between the first and second electrodes. Batchelder suggests such procedures in Column 8, lines 26-36.

Addressing claim 26, Batchelder discloses a method for using his invention, which uses the process described in this application as dielectric pumping, to move chemical fluid samples through microchannels for reaction or analysis. A sample procedure for a Ca^{2+}/EDTA titration, including reaction and analysis, is given in column 8, lines 45-68.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. Claims 5, 7, 8, 9, 11, 18 – 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Auracher et al in view of Young.

Auracher et al disclose a device as described in paragraph 6 above.

Addressing claims 5, 18, 19, and 20:

Auracher does not explicitly disclose a continuous microchannel with a tapered portion that contains a fluid interface (Claim 5), a microchannel with varying cross-sectional area (Claim 18), a microchannel with a tapering portion between sections of differing cross-sectional area (Claim 19), or a microchannel with a second fluid interface in a tapering portion between sections of differing cross-sectional area (Claim 20).

Regarding claims 5, 18, 19, and 20, Young discloses a tapered portion of the channel (11 in Figure 3). Upon application of an electric field between electrodes 5 and 6, and resulting movement of liquid 9, an air-liquid interface must exist in tapered portion 11. Young states on page 4, lines 10-12 that this tapered portion urges the

dielectric fluid 9 into reservoir 10 under the capillary effect. In order for this to be true, a fluid interface must exist within the tapered portion.

Auracher et al and Young are analogous art in that both describe optical switches that use the attractive force of an electric field on fluids with dielectric constants higher than adjacent fluids.

Regarding claim 5, it would have been obvious at the time of invention to a person of ordinary skill in the art to modify the invention of Auracher et al by including a tapered portion that contains a gas-liquid interface, as taught by Young, because such a tapered section provides a driving force for removing the dielectric fluid from the interelectrode area (i.e. turning the switch off) without additional electrical requirements.

Claims 18 and 19 list no limitations beyond those listed in claim 5, and are thus rejected by the same arguments. A tapered microchannel section will inherently connect sections of greater and lesser cross-sectional area.

Regarding claim 20, the interface within the tapered portion discussed in the treatment of claim 5 would correspond to a second interface, as the first interface is that which was drawn through the electric field upon its application. Therefore, the rejection of claim 5 is also applied to claim 20.

Addressing claims 7 and 8:

Auracher et al disclose the use of a sealed fluid reservoir in the embodiment shown in Figure 8a (the volume holding drop 14", see column 8, lines 11-14), suggesting the use of reservoirs in other embodiments.

However, in a device according to these claims, Auracher et al do not explicitly disclose a reservoir communicating with the microchannel (Claim 7) or a sealed reservoir, containing both gas and liquid, communicating with the microchannel (Claim 8).

Regarding claim 7, Young discloses reservoirs 10 and 13 (Figure 3), which lie at different points along the microchannel.

Regarding claim 8, Young discloses that the continuous microchannel is an "enclosed volume" (Page 3, lines 24-25), or sealed system, which includes both reservoirs. Furthermore, depending upon the actuation state, an interface between the liquid and gas will pass through reservoir 10. Thus, at certain points, the reservoir must contain both phases.

Regarding claim 7, it would have been obvious at the time of the invention to one skilled in the art to modify the device of Auracher et al by including a reservoir for one of the fluids, as taught by Young, because increasing the enclosed volume of gas between carrier body 30 and drop 14c (Figure 5a) would lead to less resistance to actuation and a lower required voltage for switching. One could be motivated by a desire to reduce the consumption of electricity to include a larger volume in this region, i.e. a reservoir.

Regarding claim 8, it would have been obvious to one skilled in the art at the time of the invention to modify the invention of Auracher et al by including a sealed reservoir with both liquid and gas phases, as taught by Young, because a reservoir as described above for claim 7 could include a portion of drop 14c, and thus be construed as a reservoir corresponding to the limitations of this claim.

Addressing claim 9:

Auracher et al do not explicitly disclose flow-restricting indentations in the microchannel.

Young discloses a microchannel of varying cross-sectional area as illustrated in Figure 3 (e.g. tapering section 11, widening and narrowing of the reservoirs 10, 13). Such a design inherently causes flow restriction at relatively narrow channel sections.

As discussed above in reference to claim 5, it would have been obvious to one skilled in the art at the time of the invention to modify Auracher's invention to include a tapered portion within the microchannel, as taught by Young. The narrowest portion of this tapered section will inherently cause flow restriction, which would be significant if the fluid has a high enough viscosity or the capillary becomes narrow enough.

Addressing claim 11:

Auracher et al do not explicitly disclose liquid first and second fluids.

Young discloses the possibility of using two immiscible liquids as the fluids in his device on page 8, lines 5-10.

It would have been obvious to one skilled in the art at the time of invention to modify the invention of Auracher et al by replacing the surrounding atmosphere that functions as the claimed first or second fluid with a suitable liquid, as taught by Young, because the exclusive use of liquids in such a device provides different characteristics (e.g. reduced compressibility) that might be advantageous in specific applications.

10. Claims 2 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Auracher et al in view of Lee.

Auracher et al disclose a device as described in paragraph 6 above.

Auracher et al do not explicitly disclose a device with an electrode configured to have two different potentials applied at each end (Claim 2), or a portion of the microchannel walls coated with a hydrophobic coating such that it restrains the flow of a polar liquid (Claim 10).

Regarding claim 2, Lee discloses a device of analogous function that utilizes two adjacent electrodes (Figure 1, electrodes 18 and 22) set at different potentials that function in the same way as a single resistive electrode with different potentials applied to the ends. Potentials are applied to both sets of electrodes, resulting in an electric field gradient along the microchannel. (Column 4, lines 1-6)

Regarding claim 10, Lee discloses the use of a hydrophobic coating to aid in controlling the flow of polar dielectric fluids (Figure 1, non-wetting areas 24 and 26).

Auracher et al and Lee are analogous art in that both rely upon the controlled movement of dielectric fluids by varying the application of electric fields.

Regarding claim 2, it would have been obvious to one skilled in the art at the time of the invention to modify the use of the invention of Auracher et al such that a gradient in electric field was used in the switching process, as taught by Lee, because this could result in more controlled switching, which might be desired in some instances.

Regarding claim 10, it would have been obvious to one skilled in the art at the

time of the invention to modify the device of Auracher et al by adding a hydrophobic coating over an appropriate portion of the channel, as taught by Lee, because a transparent hydrophobic coating over the fiber ends could help to keep them clear of residual dielectric droplets after switching, if the dielectric fluid were polar.

11. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Batchelder in view of Pethig et al.

Batchelder discloses a device as described in paragraph 7.

Batchelder does not explicitly disclose the manipulation of biological molecules in a fluid corresponding to the third fluid in this claim.

Pethig et al disclose the dielectrophoretic manipulation of biological molecules in a liquid phase, in a device of similar operation to Batchelder's (Figure 2, Column 4, lines 14-27). The disclosure refers to particles, but the inventors specify that the manipulated materials (whether solid, semi-solid, or liquid) be suspended in liquid media (Column 1, lines 9-10)

Batchelder and Pethig et al are analogous art because both deal with the manipulation of fluids under dielectrophoresis.

At the time of the invention it would have been obvious to modify the invention of Batchelder by replacing one of the reagent chemicals he disclosed with a dielectric fluid containing a biological molecule, as taught by Pethig et al, because Batchelder suggests the use of biological cells in his background section (Column 1, lines 32-33).

12. Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Batchelder in view of Bjornson et al.

Batchelder discloses a device as described in paragraph 7.

Batchelder does not explicitly disclose the manipulation of a drug in a fluid corresponding to the third fluid in this claim.

Bjornson et al disclose the manipulation of drug molecules in a liquid phase within a microchannel, under broadly defined "electroflow" conditions (Column 9, lines 5-22), which include dielectrophoresis.

Batchelder and Pethig et al are analogous art because both deal with electrically-induced liquid flow in microfluidic devices.

At the time of the invention, it would have been obvious to one skilled in the art to modify the invention of Batchelder by replacing one of the reagent chemicals he disclosed with a liquid comprising a drug, as taught by Bjornson et al, because Batchelder purposefully wrote a general disclosure of a device suited for broad application. His invention would provide a convenient means of reaction or analysis of drug molecules on a small scale.

13. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Auracher et al in view of Le Pesant et al.

Auracher et al disclose a third electrode (101'), which is positioned (as is electrode 101) across from electrode 201 to form a capacitor. Auracher does not

disclose a fourth electrode opposite the third, forming a second capacitor across the microchannel (Claim 16)

Le Pesant et al disclose an optical switching device that utilizes several pairs of electrodes (including first, second, third, and fourth electrodes) that are situated to form capacitors across a microchannel. In Figure 6, the electrodes are included in switching groups 47, 48, 49, and 50.

Auracher et al and Le Pesant et al are analogous art in that both deal with optical switching devices using the movement of dielectric fluids within microchannels caused by electric fields established across the channel.

It would have been obvious to one skilled in the art at the time of the invention to modify the invention of Auracher by dividing electrode 201 into two separate electrodes opposite electrodes 101 and 101', resulting in a second set of electrodes (i.e. third and fourth electrodes) positioned to form a second capacitor across the microchannel, as taught by Le Pesant, because transparent electrode 201 covers the end of fiber 2, and might reduce the transmission efficiency of the device. One might also wish to have the greater flexibility in applying electric fields afforded by independent control of the upper and lower capacitors.

14. Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Auracher et al in view of Le Pesant et al as applied to claim 16 above, and further in view of Lee.

Auracher et al and Le Pesant disclose optical switches as described above.

Neither Auracher et al nor Le Pesant disclose the use of a resistive electrode with different potentials applied to the ends.

Lee discloses a device of analogous function that utilizes two adjacent electrodes (Figure 1, electrodes 18 and 22), set at different potentials that function in the same way as a single resistive electrode with different potentials applied to the ends. Potentials are applied to both sets of electrodes, resulting in an electric field gradient along the microchannel (Column 4, lines 1-6).

Auracher et al, Le Pesant et al, and Lee are analogous art in that all rely upon the controlled movement of dielectric fluids by varying the application of electric fields.

At the time of the invention, it would have been obvious to one skilled in the art to modify the combination of Auracher et al and Le Pesant et al described above by including additional switches configured vertically along the channel, with at least one of the switches utilizing an electric field gradient generated by adjacent sets of electrodes, as taught by Lee, because such an arrangement would increase the density of optical switches in the device.

Allowable Subject Matter

15. Claims 3, 22, and 23 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The primary reason for allowance is that the prior art of record did not show the use of a resistive electrode having different potentials applied to the ends, situated

opposite a non-resistive electrode having a potential intermediate those applied to the ends of the resistive electrode. This electrode configuration is deemed to provide a nonobvious improvement over the invention of Auracher et al.

Conclusion

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jeffrey Barton, whose telephone number is (571) 272-1307. The examiner can normally be reached Monday-Friday from 8:30 am – 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen, can be reached at (571) 272-1342. The fax number for the organization where this application or proceeding is assigned is (703) 872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at (866) 217-9197 (toll-free).

JTB
May 13, 2004

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